

Perihelion Concentration of Comets

III. Physics and Astrophysics

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Abstract. The problem of concentration of cometary perihelia on the sphere is discussed from the point of view of physics and astronomy. The important facts which may be crucial in understanding the observed concentration of cometary perihelia in the direction of solar apex are presented.

1. Introduction

Investigations of the last decades (see references in paper I of this series) lead to the conclusion that perihelia of long-period comets exhibit concentration in the direction of solar apex. The aim of this paper is to discuss this result from the point of view of physics and astronomical observations.

2. Cometary Perihelia and Solar Apex – Basic Properties

If the observed concentration of cometary perihelia in the direction of solar apex is of physical nature, then one should await that the comets are of interstellar origin, i. e., the observed orbits of the comets are characterized by osculating eccentricities mainly $e > 1$. No concentration in the direction of solar apex should be observed from the physical point of view for the case of solar system origin of the bodies.

Important property pointing to the significance of the observed concentration in a given direction consists in the simple fact that the same direction (approximately) must

be obtained for various subsets of the fundamental input data (orbital elements). These subsets may be of two types, in principle: i) subsets defined by time intervals, e. g., the subset of the oldest known bodies and the subset of the newest known bodies; ii) subsets defined by geometrical conditions, e. g., the subsets are given by various values of maximum value of perihelion distance. If the observed concentration of cometary perihelia in the direction of solar apex is of physical nature, then this direction of concentration must be independent on a value of q_o , where q_o is a given value defining a subset of comets characterized by perihelion distances $q \leq q_o$.

3. Cometary Perihelia and Solar Apex – Kinematics

The observed concentration of cometary perihelia is in the direction of solar apex. If the comets are of interstellar origin, then the physical contents of the term “solar apex” is given by galactic astronomy and can be applied on our case. We will do this application, now.

Let us consider the situation when the velocity vectors of comets far away from the Sun, in the interstellar space, are uniformly distributed with respect to the reference frame rotating around the galactic center; the origin of the frame corresponds to the place of the Sun. Any subset of the comets defined by a small volume in the interstellar space near the Sun yields zero final velocity vector (defined for the center of mass) with respect to the reference frame, and, the motion of the Sun with respect to the subset of comets is consistent with the term solar apex. Since the observed concentration of cometary perihelia is in the direction of solar apex, more comets must be situated behind the Sun than in front of the Sun (the term ‘in front of’ means that radii vectors of comets with respect to the Sun are of the same orientation as is the direction of solar motion – orientation toward the solar apex).

Let us consider the situation when the radii vectors of comets far away from the Sun, in the interstellar space, are uniformly distributed with respect to the Sun – concentration of comets is independent on position with respect to the Sun. Since the motion of the Sun with respect to the comets corresponds to solar apex, the motion of the comets with respect to the Sun is in the direction of antapex – the perihelia of the comets are situated in the direction of antapex. This is not consistent with observations – the perihelia of the comets are situated in the direction of apex. Thus, at least one of the assumptions – interstellar origin of comets, concentration of comets is independent on position with respect to the Sun, solar apex determined from comets is consistent with solar apex determined from various types of stars – is not fulfilled.

4. Cometary Perihelia and Solar Apex – Astronomy

Astronomical access to the result given by observational data (observed concentration of cometary perihelia is in the direction of solar apex) tries to consider observational selection effects which could influence the observed concentration. The well-known observational selection effect – manifested not only in cometary data, but also in data on asteroids – may play decisive role. The observational selection effect reflects the situation that observations were made at favourite observational conditions – at sites Europe (northern hemisphere of the Earth) prevails observations from may to september.

5. Conclusion

We have presented physical and astronomical considerations which can play an important role in our understanding of the observed concentration of cometary perihelia in the direction of solar apex. All these considerations must be taken into account when dealing with the data and making final statements on the significance of the concentration of cometary perihelia in the direction of solar apex. One must try to find which of the discussed possibilities can be found from the data. Application of the paper is presented in other parts of this series of papers.

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